CONSTRUCTION FUNDAMENTALS

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ROAD DESIGN FUNDAMENTALS - CONSTRUCTION FUNDAMENTALS COURSE OUTLINE

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FOREWORD

This booklet is meant to be used as a quick reference for many of the construction fundamentals that the road designer will encounter. It is not a substitute for on-site visits and/or discussions with MDT construction personnel and contractors. These visits and discussions are the best source of information for any particular road design project.

This booklet provides some insight into the basic construction activities which take place during the building of the project. The methods and suggestions come from design and construction personnel and are provided as guidelines and examples for the designer to use in completion of the road design project. There are other equally valid methods and techniques not covered here. The designer is encouraged to review and evaluate all methods against his or her current design procedure.

The user is encouraged to provide comments and suggestions on how to improve this course and the course contents.

I INTRODUCTION

This booklet is being presented for the road designer who may have very little construction experience. The course is set up to supply basic construction information to the designer so that he/she can produce a better set of plans and contract documents which will be more applicable to the MDT construction crew and the contractor.

It has been stated that anything can be built on paper. In most cases, the paper design can also be built in the field. The biggest problem facing the designer is not putting the design on paper that the checker or another designer can understand, but putting a design on paper that the MDT construction crew and the contractor can understand. Far too many designs are approved by design personnel without getting input from the construction personnel.

This problem is basically caused by a lack of communications. A lack of communication between the designer and the MDT construction personnel is caused by several factors:

1. Stereotypes-
From the designer's point of view: the construction personnel don't understand the complex design process the designer must go through, especially with the new environmental concerns and new computer design we are using. They (construction personnel) have to understand that we had to jump through a lot of hoops to get the design completed, and they just can't change it during construction to fit their needs.

From the construction personnel's point of view: the designer sits in that air-conditioned office playing with his new computer to come up with this road design. What they need to do is spend some time out here with us and learn how we really do it. Then they might understand how we deal with traffic control, irate contractors and landowners, and how the real world operates!

This us and them stereotype will not prove productive for either side. We (all of us and all of them) must start striving for better communications. This will allow the MDT team to produce better and more cost effective plans and will allow the plans and contract documents to reflect both design and construction

concerns. This will ultimately lead to less change orders, more cooperation, and better roads for the department to maintain and the driving public to use.

2. The second major communications problem we have in the department is no established communication lines between design and construction and maintenance. Sure we have written memos and these new fax machines, and almost every person has immediate access to a phone- but do we really use these lines of communication? Unfortunately, not as often as we should. How many times, as designers, do we follow up and see if our projects were built the way we (no let's leave the we out of it); the way that the project was designed? In turn, how many times have designers heard back from the construction personnel as to what went right on the project, or what went wrong and could be redesigned to be more functional? How often does maintenance convey maintenance problems to construction or design?

It is true that construction and design talk to each other when the problems get to a certain level of magnitude. But this communication is usually on the same level of magnitude as to the personnel communicating (the bureau chiefs or section heads). The communications need to be at a less formal level and need to be between the designer and the construction crew and the contractor. (This is the same concept our partnering experimental programs are working with.) In turn, maintenance has to let all parties know what has worked and where our long term failures are.

This concept is not new, nor is it that difficult to achieve, if all parties approach it in the correct frame of mind. It must be remembered that the process and the end result are being analyzed, and even criticized, but that this is constructive criticism and it is not directed at individuals or groups, but at the process or end product.

Both design and construction know that it is much easier and faster to tear down the bridge (or system) then it is to design and build it.

This course is meant to help the designer understand the construction personnel's and contractor's point of view in the road design and construction process. It is going to be very brief and only a few detailed

situations are going to be covered. The designer is encouraged to take this basic information and begin to expand upon it during their day-to-day design assignments.

Let us first look at some general construction practices to introduce us to the construction process.

II GENERAL CONSTRUCTION PRACTICES

As a group, we probably understand the contractor bidding process fairly well, so we will not go into detail at this time. But what happens when that contractor is awarded the construction project?

Our bidding process has been likened to a poker game where the contractor with the losing hand (lowest bid) gets the pot (construction contract). Sometimes this analogy is correct, especially if the contractor estimated off a poor set of contract documents or the contractor's estimator made a mistake. Remember the contractor has had only a short period of time (around a month or so) to put his bid together.

A. CONTRACTOR PRACTICES

So now it is up to the contractor to turn this losing hand into a winner. How is this going to be done? First, let's assume everything works out so that the contractor has a good set of design documents and the estimator did not make a mistake. The contractor is going to turn this losing hand into a winner ($) by:

1. Efficient use of the resources. The contractor will need good, productive workers and a good knowledge of material suppliers for finished materials such as culverts, guardrail, and concrete. Also, a good knowledge of the sources of raw materials such as gravel and borrow pits and efficient earth moving techniques is helpful.

2. Cooperation with the landowners and MDT construction personnel. The contractor realizes that all the paper documents and signed agreements are not going to cover all situations. The daily give and take process and good communications with all parties is going to allow the project to proceed at its fastest rate.

3. Innovative construction practices. This may be

the major reason the contractor received the bid. If the contractor can more efficiently move earth or crush gravel or lay down plant mix, then his average bid prices will be lower than his competition and he will still be able to turn a profit.

For example, the use of a water pipeline or drilling wells may be more cost effective than hauling water in trucks. Each contractor is constantly looking for a better way to do things and is constantly searching for a new trick to add to his bag of goodies.

4. Understanding the construction and design process. If the contractor understands both the construction and design process, he/she may be able to take advantage of better or innovative designs or materials to produce the same end result product. The contractor may be able to suggest a value engineering proposal which may save the state and the contractor money while still providing the same desired end product.

An example that comes to mind is the contractor inserting a smaller size culvert inside a corroded metal stockpass. The contractor was able to justify the higher culvert installation costs for grout and labor by comparing it to the cost for a culvert replacement including detour construction, culvert excavation, and traffic control costs. The contractor saved the state and the contracting firm money while still providing an acceptable end product.

These four main items are responsible for the "good" contractors staying in business by turning a profit and for the "poor" contractors keeping that "losing hand" and eventually folding.

Let us now look at the contractor we are always on guard for - the notorious (but sharp) money grabbing character who takes advantage of the system. (Remember, we wrote the system and the contractor has learned it very well, sometimes from the school of hard knocks.) In addition to the four ways previously stated, our greedy contractor has a few other methods to turn a profit:

1. Use of "borderline" resources. Workers who are willing to take shortcuts when the MDT inspector is not looking. Another tactic is to overwhelm the MDT construction crew by throwing a lot of equipment and

operations at the small construction crew, and then working double shifts (16 to 18 hours) per day to keep the construction crew off guard and unable to properly inspect all operations in detail. Some contractors will also replace good quality workmanship with a job that is "good enough to pass inspection," especially if the inspector is new or a temporary worker.

Another tactic is to produce "borderline" gravel, plant mix, or other items that will just meet the quality assurance specification or even be just slightly below the specification and then take a price reduction if and when the defect is proven.

2. "Bullying" or intimidating the landowner and MDT construction personnel into cooperation. Some contractors use this practice "to tip the scales in their favor." With new construction personnel and landowners who are somewhat naive to the whole construction process this can be accomplished at times.

An example of this is the negotiation of borrow sources with the landowner. The average landowner may not be aware of some contractor practices such as paying royalties on the net borrow removed, while the contractor is being paid by the state for the in-place borrow removed (unclassified borrow). The contractor pays the landowner on the net borrow removed, using the borrow pit to dispose of digout excavation, wasted plant mix, etc. Another practice on an embankment-in-place project is to let the landowner know what quantity the state paid for the borrow and reimburse the landowner royalty on this amount. This neglects the fact that the borrow is compacted on the roadway and the royalty quantity may not include contractor used borrow to build haul roads, cross overs, and detours.

3. Out-of-specifications construction practices. Some contractor's will instruct their workers to violate the specifications whenever possible and then reward the worker with a bonus based on production. This practice is especially effective as some of the results of out-of-specification work do not show up for years. Improper consolidation (compaction) of earth fills and pipe backfills may not be noticed within the project time frame, but will show up in long term settlement which maintenance or the next plant mix overlay must correct.

4. Exploiting the construction and design process. Some contractors will "feed upon" the differences (and problems) between construction and design. Some contractors will get approval for "an equal product" through design personnel, when in fact the equal product doesn't perform equally as well as the specified product. Another tactic is to convince the construction personnel that a design criteria is too stringent or that it "really won't matter" which way the product is built - just that it gets built.

Most of these contractor ploys or tactics are well known by almost all construction and most design personnel and are monitored very closely. This is not to say all contractors employ these tactics, but that they are used commonly enough to warrant mention.

We are not trying to introduce an antagonistic approach to the contractor/MDT personnel situation but to point out that these situations do arise at times. Also it must be remembered this is being written from the MDT's point of view.

B. END RESULT SPECIFICATIONS AND PRODUCTS

End result specifications are the backbone to the competitive bid process and allow the department to receive an acceptable end result for the least cost. Free enterprise at its finest!

This system entices the contractor to put his combined efforts and skills against other contractors to produce the same end product. We as MDT employees (design, construction, and maintenance personnel) are held responsible to determine that our design, construction, and maintenance policies and procedures determine these same end result products.

So if the contractor wishes to use horse drawn wagons or modern scrapers and trucks it should make no difference to the MDT as long as the end product is the same and the contractor can complete the project in the allotted project time frame. The MDT employees need to recognize when a substandard product or technique is not going to produce the desired end result product and more importantly how to prevent that substandard item from being introduced.

Let us now turn our attention to the road contractor's sequence of operations to gather some background on

how the contractor approaches the construction phase of the project.

III CONTRACTOR SEQUENCE OF OPERATIONS

The contractor can set up his operations in any fashion that he/she chooses. Most contractors will follow an established sequence of operations that is dictated by logic and prior experience. Most contractors will follow the general sequence of operations described below.

1. After being awarded the bid, the contractor is issued a formal, written notice to proceed from the MDT and the contractor begins to mobilize his operations. His first order of business is usually to apply for all the proper permits that will be necessary to complete his operations. These permits are usually obtained from federal, state, local, and tribal agencies. Permits may also be necessary from private entities such as railroads and utility companies.

Air quality permits must be obtained for hot plant emissions, dust from gravel crushing and hauling operations, as well as for burning of cleared vegetation and trees (if permitted). Water quality permits are required for building a structure in or over a stream, placing riprap, or any major land clearing operation which can cause wind or water born sediment to reach any water source. Water quality permits may also be necessary for drilling water wells or using surface water for the contractor's operations.

> ☞NOTE: The erosion control plans developed by the road designer are used at this stage by the contractor to obtain his water quality permits.

Mining permits are required for some gravel pits and borrow sites as this activity falls under the surfacing mining act. Pit reclamation plans must also be filed at this time to assure the borrow and gravel pits will be reclaimed to a nature condition. Permits for waste water discharge from wet gravel pits and from structure cofferdams are also necessary.

Haul roads which cross adjacent land owner's property,

railroad crossing permits, and permits for crossing utility lines and right-of-ways must also be obtained. Landowner agreements for royalty payments on borrow sites as well as use of land for contractor staging areas or use of surface water or water wells must be negotiated and signed.

Agreements with unions and TERO (Tribal Employment and Recruitment Organizations) must be negotiated and signed if not already in place. Some tribes require work permits for all workers to work on projects within tribal jurisdiction. Agreements for fuel purchases and electrical power must be negotiated and signed. Local vehicle registration and contractor licensing requirements must also be met.

The prime contractor is expected to complete more than 50% of the required work with the contractor's own equipment and work force. The prime contractor may hire approved subcontractors to complete any work items. The MDT deals directly with the prime contractor in all instances and the subcontractor is directed by the prime contractor. Payment is made directly to the prime contractor as is all correspondence and directions from the MDT.

2. After the contractor obtains all the necessary permits, he/she usually commences to build an access road (if it doesn't already exist) to the gravel pit. The contractor mobilizes his equipment to build the road and begin gravel crushing operations. At this point, the contractor usually sets up the project office and phone and also obtains an equipment staging/storage area. If the staging area is not available within the highway right-of-way, the contractor may lease an area adjacent to the project.

3. At this point, the contractor usually places the traffic control signing at each end of the project, alerting the general public to construction activities. The project will require constant maintenance and upgrading of traffic control as dictated by the construction activity. Lane closures will require signing, possibly flaggers and pilot cars, and all the assorted traffic control devices which go with them. The Manual on Uniform Traffic Control Devices (MUTCD), MDT Standard Drawings, and MDT special provisions and specifications all provide the contractor and MDT construction personnel with set guidelines and specific traffic control guidance.

Traffic control cannot be overemphasized on the construction site. Good traffic control can make for a smooth flowing project from the department's, contractor's, and general public's viewpoint. Poor traffic control can cause a nightmare for all parties. (More on traffic control later in this booklet.)

4. Underground utilities must be located before each phase of construction proceeds. The MDT has coordinated relocation of the major portion of the utilities prior to beginning construction. The contractor must have the remaining utility crossings located and their depth verified, prior to commencing any operations which will come in contact with the utilities.

5. Clearing and grubbing activities usually begin next. The contractor must remove and dispose of the cleared vegetation and trees to allow topsoil operations to begin.

6. Topsoil is salvaged from the construction limits and stockpiled for placement on the future finished slopes. New fencing may be required prior to topsoil removal if the construction limits are outside the existing fencing.

7. Structure construction will usually begin next. If the project is being built adjacent to or on the existing roadway then a detour may be necessary to allow the new structure to be built. The detour route must be in place before the existing area can be closed to traffic and structure construction begun. (More on detours later in this booklet.)

The structure fabrication will usually be a major portion of the contract time. It is important to begin the structure as soon as possible to allow enough time for formwork to be built, rebar to be placed, and the concrete to cure. It must also be remembered that structures usually require cranes, welders, concrete trucks, etc. to build. An adequate staging area immediately adjacent to the structure is needed for the associated bridge building equipment.

8. New fencing can be placed at this time and the old fencing removed in advance of the topsoil salvaging. If new fencing is not required or if the old fencing is adequate, the contractor may not need to fence. If the new fence is to replace the old fence in the same

location and the old fence does not interfere with construction activities, the old fence can remain and the new fence can be constructed at any time during the project.

☞NOTE: Fencing is usually required to keep livestock off our roadway. An enclosure must be maintained at all times if livestock is present. Temporary fencing or the landowner relocating the livestock (possibly through the right-of-way agreement) are solutions to the problem.

9. Temporary and permanent erosion control features should be in place before any construction activities create sediment or the possibility of sediment. Water for traffic dust control should also be available as topsoil salvaging equipment or detoured traffic can create dust and cause air quality problems and/or sight distance problems.

10. Culvert extensions on widening projects and new culvert installations are usually begun right after topsoil salvaging operations. If the existing PTW (present traveled way) is disturbed by a culvert extension or placement, new plant mix surfacing is usually placed on the disturbed PTW. The contractor needs to know this up front in the contract documents, and he must make arrangements to get plant mix surfacing from an adjacent commercial hot plant or possibly purchase some cold mix from maintenance, as the contractor's hot plant is usually not functional at this time.

11. Earthwork operations usually follow the topsoil salvaging and drainage work. Cross overs, haul roads, and any conflicts with the PTW must be coordinated and the traffic control in place before the earthwork commences. The traffic and earth moving equipment cannot be allowed to compete for space.

Water will be necessary to build fills and a water distribution system must be in place to provide the required water. (Fills must be constructed at ±2% of optimum moisture.) Sometimes the removal of excess moisture requires discing the soil or working it to allow evaporation. Sometimes subexcavation is required to remove poor soils and to allow placement of better soil materials. Most of the time the

subexcavated material is not suitable for embankment construction and the material is wasted or disposed of by the contractor. Sometimes this disposal can take place on the highway right-of-way and sometimes the contractor must find a disposal site. A low lying area or a used borrow site can sometimes be used as a disposal site if the landowner (MDT or private owner) agrees.

Digout material poses the same problem on overlay projects. The digout excavation usually specifies that the contractor must dispose of the excavated material. Some contractors are incorporating the removed surfacing gravel and pulverized plant mix back into the subgrade construction. Most of the excavated subgrade material must be disposed of or used in the toes of the fills.

12. Contractor bluetopping is the next course of business, when the subgrade reaches the specified height. The contractor is responsible for providing a survey crew to place the bluetops to within ±0.05 ft. of true elevation. The MDT supplies the contractor with the existing benchmark (elevation) data and if need be the referenced centerline (transit notes) data. It is the contractor's responsibility to maintain the horizontal and vertical alignment on the project after it is established by the MDT survey crew. Many contractors subcontract the bluetopping to an engineering firm.

13. After the subgrade has been bluetopped, the next course of action is placement of the gravel course or courses. Each type of gravel must be bluetopped to assure the proper width and depth. Some MDT districts do not bluetop the last course of gravel and some road leveling equipment is in use which eliminates bluetopping. For now, most projects will require contractor bluetopping of all gravel courses. Once the final gravel course is placed and the correct elevation and width established, the gravel is "primed" with an asphalt prime, usually MC-70.

14. After the prime cures (solidifies), the roadway can be opened back up to traffic. If the roadway is being built under traffic, the operations which require a lane closure (on two-lane roads) will need to be coordinated so the driving public has a minimum of one lane at any given time. On most two lane roads, the one lane is closed because of construction

activities and the two-way traffic alternates use of the remaining one lane. This is accomplished by use of proper signing, flaggers, and possibly pilot cars.

If the roadway is not being built under traffic, the contractor is free to work on both sides of the roadway as his activities dictate.

15. By this time, the project structure(s) should be nearing completion, the subgrade should be placed adjacent to the structures and the gravel surfacing ready to be paved. If the structure(s) is not yet ready, these activities will need to be completed at a later date.

16. Cold milling on overlay projects is usually the next construction activity. Cold milling is used to remove rutted plant mix surfacing or to allow an overlay in a curb and gutter situation. Additional lifts of plant mix will then be constructed until the roadway reaches the specified thickness. If the roadway is being built under traffic, the paving and milling operations will alternate between each side of centerline and the pavement operation "stair steps" its way to the finished grade. Temporary pavement markings are applied for each lift if the project is under traffic. Approaches will usually be paved as the last lift of plant mix or if thicker than 0.20' plant mix is required, as the adjacent mainline lifts are being built.

17. After the plant mix is placed, guardrail that was removed for a widening and overlay project just prior to the plant mix overlay is now reset. New construction or reconstruction will have the new guardrail posts and rail placed at this time.

18. Shoulder gravel slopes will be dressed with a motor patrol. Delineators will be placed and the permanent signing may begin. The pavement could receive a plant mix seal at this time with final pavement markings applied. The roadway could also receive the seal coat at a later date. Urban areas will not receive a plant mix seal and the inlaid thermoplastic pavement markings will be applied.

Traffic signals and lighting operations may begin prior to the paving operations or can be done at this point in time. It is important that loop detectors and any conduits that need to have been run in the

pavement are completed as the plant mix operation progresses. Electrical services can be pushed or bored under the roadway, or can be completed prior to surfacing placement.

19. The stockpiled topsoil can be spread on the finished slopes as soon as the subgrade is completed. If the subgrade is going to remain in place over the winter without topsoil being placed, temporary seeding may be appropriate to prevent excessive erosion and sedimentation problems during spring snowmelt. Once the topsoil is placed on the finished slopes it should be left in a rough condition that will collect and retain small puddles of water. It should be promptly seeded and fertilized to promote plant growth and reduce long term erosion.

20. Other contractor operations may progress as the project schedule dictates. Mailboxes furnished by the MDT can be installed when the approaches or turnouts are built. Mailbox turnouts should be built as the subgrade work progresses, and paved with the adjacent mainline lanes. Gravel guardrail widening and end section widening should be built prior to the guardrail installations.

Embankment protectors can be built late into the project but are best placed just before paving operations. Bituminous curb is placed under the guardrail face and is usually placed after the guardrail installation and embankment protector installation. Riprap chutes and other erosion control features are usually placed as the earthwork progresses.

Curb and gutter as well as sidewalks should be placed after the gravel surfacing is in place but prior to the plant mix surfacing. Curb and gutter will become the finished grade control for the plant mix surfacing.

21. Contractor cleanup consists of removing debris and large rocks from topsoiled slopes, removal of wasted plant mix surfacing and concrete waste, as well as concrete formwork. Any excess materials or items to be salvaged are disposed of or hauled to the salvage sites. Old existing fencing materials are returned to the adjacent landowner or disposed of by the contractor.

Culvert cleaning on overlay and widening projects may be completed at anytime but seems to be one of the last minute details for most contractors. Water and gas valve risers and manholes are usually adjusted to grade as the final plant mix lift is placed. Sometimes minor adjustments are necessary and are completed as cleanup items.

Any eroded slopes which remain will need to be dressed and possibly reseeded. Detour areas are removed as the project schedule dictates and need to be contoured and reseeded. Sometimes detours are the last item to be removed if a structure has been holding up the project.

22. All final items are completed by the contractor to the satisfaction of the engineer and the project is presented for final acceptance. If the project is accepted by the MDT, maintenance takes over responsibility for the project.

23. The contractor will then remove the project traffic control signs and remaining equipment. The contractor may still have to complete pit reclamation on private property, but all work within the highway right-of-way should be completed.

This briefly outlines the contractor's sequence of operations on a roadway project.

As the contractor proceeds through the project construction, the MDT construction crew has certain duties and responsibilities which they must follow.

Let's briefly look at these duties.

IV MDT CONSTRUCTION CREW SEQUENCE OF OPERATIONS

The MDT construction crew doubles as a survey crew and inspection crew depending on the circumstances. The crew is headed by a field project manager who oversees the day to day survey and construction activities. The project manager usually oversees a project crew of 5 to 20 personnel. (The ranks usually swell with summer employees, with most crews consisting of 5 to 10 permanent employees.) The project manager answers to the District Construction Engineer who in turn answers to the District Engineer.

Let us briefly outline the construction crew's activities below:

1. Prior to the contract being let, all utilities are to be relocated. This requires the construction crew to verify or even resurvey the projected centerline and to put permanent monuments out on the new right-of-way. The crew then oversees and documents the utility relocations.

2. The crew is responsible to have enough of the project slope staked and culvert locations staked for the contractor to begin his operations when issued the notice to proceed by the MDT. The crew will continue to slope stake and survey on other construction items as the contractor begins his operations. The crew must now split its time between inspecting whatever construction activities the contractor is proceeding with and completion of their construction survey responsibilities. Additional construction crews may be needed to help keep the survey and construction inspection work proceeding ahead of the contractor.

If the MDT crews cannot keep in front of the contractor's operations, the contractor may have a legitimate claim for compensation and/or extension of the project contract time. This can be a real crunch time for the construction crew with everyone breathing down their necks. Unfortunately this is about the time design problems will appear. If the design problems do not appear, the crew counts their lucky stars and continues on their frenzied way, hoping to get enough done during the daylight hours to keep the contractor's equipment from running over their survey rig containing the plans and more importantly, lunches and soft drinks.

3. Once the mainline and approach earthwork or "staking" notes are completed they are quickly checked and sent to Helena to produce a staked earthwork run. A copy of the transit notes, staking notes, and level notes are forwarded to the contractor for use by the grade setter ("stake jumper") and the bluetopping crew.

4. Usually the contractor has culvert work, earthwork, and topsoil salvaging operations going on at the same time. The construction crew must document all traffic control devices, flaggers, and pilot cars

in use. The construction inspector is checking that the earthwork fills are being placed in horizontal 8" lifts (maximum loose measurement) and being compacted to 95% of maximum density at ±2% of optimum moisture.

The culvert inspector is checking for culvert defects, for proper elevation of the culvert, and most importantly that the backfill is properly compacted and placed in uniform lifts. The topsoil is stockpiled out of the construction limits and the construction crew measures the stockpiles for contractor payment by survey methods.

5. Once the earthwork is completed, the contractor bluetopping is checked by the construction survey crew for line and grade. If correct, approval is given to the contractor to place gravel courses. If bluetopping errors are found, the bluetopping crew is asked to redo their work.

☞NOTE: The top 2 feet of subgrade should be sampled by MDT personnel and sent to Helena for R-value testing to assure the proper design R-value has been met. In selective grading projects or where the contractor is to provide a specified R-value borrow, the point of delivery on the roadway is the sampling point. Acceptance of the subgrade is based on the reported R-values from the tested samples.

If the subgrade is inadequate (low R-values), the option remains to proceed with the construction but expect premature failures, correct the situation through subgrade removal, or correct the situation with increased surfacing. If the subgrade was not specified at a certain R-value, the cost of correction is the MDT's. If the subgrade R-value was specified, the contractor is usually responsible for the correction. (The "good" R-value material had to be obtainable in a quantity that would build the top 2 feet and the contractor had to have ignored this fact to be held liable.)

The department has selected all three options on different projects and the solution for each situation must be handled on a case-by-case basis.

6. New fencing is inspected for workmanship and

samples are taken and tested for wire and fence posts. Fencing is measured by the survey crew and paid by the rod. Panels, deadmen, cattleguards, and gates, as well as temporary fencing must all be inspected, verified, and measured for payment.

7. Temporary erosion control items are usually paid on a force account basis with the inspector closely watching the workmanship, recording the worker's hours, and documenting the materials used. This is usually paid on a cost plus basis per agreed force account procedures.

8. Drainage items (concrete cutoff walls, edge protection, and riprap) are all inspected for proper formwork and placement, and the concrete, rebar, and riprap sampled to verify quality. Quantities for payment are determined by field measurement (for riprap and construction fabric) and by plan quantities for the concrete items at the specified dimensions.

9. All surfacing items are sampled on a random sampling basis and all gravel, plant mix aggregate, mineral fillers, and asphalt products are measured and paid at the contract unit prices. Quality assurance tests of the random samples assure quality materials with price reductions for inferior quality.

The construction inspector also checks the gravel base for proper compaction and moisture as well as for proper elevation. Plant mix surfacing is inspected for proper compaction (density) requirements and proper thickness. All quantities are determined by measured weight or volume, or by survey methods (bluetops) for volume.

10. All other items used on the project are measured and documented for payment per the contract bid prices. All materials are sampled for quality such as paint, reflectors, delineator posts, glass beads, guardrail hardware, and aggregate for chip seals.

11. Topsoil replacement, seeding and fertilizing, sign installation, guardrail installation, and project cleanup are all witnessed or verified, and measured for payment.

12. The construction crew's final responsibility is to verify all quantities via documented notes and to produce the as-built construction plans for the

project. An additional responsibility is to review the right-of-way monuments and to verify they are still in place. If any monuments are missing, the crew resets the monument.

As we now see, the construction/survey crew has a wide variety of tasks to complete during the construction phase of the project.

Let us now concentrate on some of the items which go into the contract documents and which have a tendency to be seen as constant problem areas for the construction personnel.

V DETOUR DESIGN

First we will look at 2-lane highway detours that will be used on most of our primary and secondary routes. We will also group median crossovers into our interstate detour design. We will discuss lane closures in the traffic control section of this booklet.

A. TWO-LANE DETOUR

The basic 2-lane highway detour layout is shown in appendix A and comes from standard drawing number 204.

No design speed is stated for detour construction and it has been left to the discretion of the designer. The rule of thumb for designing detours is to design all features for 10 MPH below the posted speed limit and to put up advisory and regulatory speed limit signs at 35 MPH in most cases.

Horizontal and vertical alignments should meet this requirement. The clear zone should be designed from this detour design speed requirement with 3:1 slopes or flatter. It is important to remember that the 3:1 slope is non-recoverable and the vehicle is going to need recovery space at the bottom of the 3:1 slope. The clear zone can be determined from the AASHTO ROADSIDE DESIGN GUIDE.

The type of detour surfacing and detour roadway width is dependent on the length of time the detour is to remain functional, the design speed, and the traffic ADT. The detour surfacing, as well as the entire detour design, should be a detail in the plans and should be discussed and approved by the plan-in-hand

committee.

Another design item is the type of drainage structure to be used for the detour. The drainage structure size and type is dependent on the detour life and roadway ADT. The Hydraulics Section should be consulted and their recommendations taken to the plan-in-hand committee for consideration and approval.

The detour traffic control devices, flaggers, and signing requirements are governed by the blue sheet special provisions and the standard drawings. The detour design and/or detour special provisions should reference the appropriate standard drawings and existing traffic control special provisions.

The road designer should also take into account that the permanent structure being built will require room for equipment (cranes, concrete trucks, etc.) to work around the new structure. It is a good idea to discuss the equipment area requirements with the Bridge Bureau (bridges) or Hydraulics Section (drainage structures) before beginning the detour design. It is the designer's objective to use the minimum detour length and minimum detour materials to reduce detour costs. The designer must balance these considerations with the detour safety and function to achieve a well designed detour.

Once the detour design has been approved by the plan-in-hand committee, the construction limits need to be forwarded to the Right-of-Way Bureau so a construction permit can be designed. The designer must also remember to establish a method of payment for incidental detour design items such as removed fencing and reseeding of the disturbed areas.

Most detour designs are completed as a lump sum package for the contractor to bid on. The designer should establish the necessary detour quantities and list them for informational purposes. This allows the contractor to put the detour lump sum bid together rather rapidly, and cuts down on the contractor hedging his bid due to uncertain quantities and speculation as to what the detour construction truly requires.

Most detour lump sum bids also are worded so that the contractor must include detour maintenance into the bid item. This is especially important when the

detour was designed for a week and the contractor has been using it for a month.

A copy of a sample detour special provision is shown in appendix A.

It is important for the designer to remember that the detour is a temporary construction item and will not remain after the project is completed. It usually serves a very limited life and some major concessions in the design of this temporary detour can save substantial amounts of time and money. If the detour is on a remote, low ADT roadway, an alternate to a costly constructed detour may be a road closure, provided the increased travel distance is not too great. Another option is to consider a lower design speed and incorporate flaggers and/or pilot cars into the design.

For example, in rolling terrain the cost of constructing appropriate fill slopes can be quite high for a 45 MPH design speed detour (55 MPH posted speed limit on roadway). An alternate approach would be to design for a 25 MPH design speed, use flaggers and pilot cars and post the detour speed limit at 15 MPH.

This can dramatically lower embankment construction costs and now gravel is probably a suitable surfacing. Each case is going to have to be handled individually. If the designer consults bridge or hydraulics for a detour design life, this alternate detour cost can be calculated and compared to the conventional detour design.

If the flagger option is used it may be in the designer's best interest to set up an incentive /disincentive situation for the contractor to complete the mainline structure within the allotted timeframe or the anticipated cost savings will be eaten up with expensive traffic control measures.

Once the designer has all the design assumptions and data determined, a cost analysis can be computed and all these options can be presented to the plan-in-hand committee for consideration. The designer is well advised to do this type of comparison prior to the plan-in-hand so concrete numbers can be presented and so the committee can make a decision at the time of the plan-in-hand.

☞NOTE: Major departures from present MDT detour design practices should receive approval from the plan-in-hand committee and the Preconstruction Engineer. The plan-in-hand report is a good place to document the decisions and reasoning and to bring it to the Preconstruction Engineer's attention.

B. MEDIAN CROSSOVERS (INTERSTATE):

Median crossovers on the interstate can be thought of as interstate detours. The designer should consider using an existing interchange/frontage road system for the detour before resorting to median crossovers. If this option is not available, or it is not appropriate, begin the median crossover design.

The basic median crossover designs are shown in appendix A and come from standard drawing numbers 205, 206, and 207. The crossover is designed with a 10:1 horizontal taper rate, 14 foot driving lanes, and 3 foot shoulders as shown in these drawings.

The median crossover is paved and built with 10:1 or flatter fill slopes usually being required. Concrete median barrier rail, impact attenuators, and median traffic devices are usually used. Please see the sample special provisions in appendix A titled "Traffic Control Plan and Sequence of Operations" and "Concrete Median Rail and Impact Attenuators" for guidance.

The median crossover design (surfacing depths, quantities, etc.) need to be shown in the plans. Quantities are usually shown for informational purposes and the item is usually bid as a lump sum - "Median Crossover."

All median crossover design items should be discussed and approved by the plan-in-hand committee.

VI TRAFFIC CONTROL

The traffic control plan determines how a project will be built and how much "interference" the contractor will have in completing the construction. If the roadway can be closed to traffic, the contractor will be able to work unhindered and the total project bid

should reflect lower bid prices. If the contractor has to work under traffic, the bid prices will be higher as the "interference" from the traffic must be factored into the total project bid. The project being built under traffic will have a larger quantity of traffic control bid items (devices, flagging, and pilot car) than the project without traffic run through it.

This design consideration should be determined at the beginning of the project design. If the designer is in doubt as to which way the project traffic control will be handled, the design supervisor and/or construction personnel should be consulted. The project traffic control plan should be stated in the special provisions and should supply the construction crew and contractor with guidelines on how the traffic will be handled. Specific items regarding detour location and quantities, the number of detours permitted at any one given time, and general items on lane closures, flagging, and pilot car operations should be referenced to standard drawings or other special provisions.

The intent of the traffic control special provision is to offer guidance to the contractor, but allow the contractor the flexibility to choose which operations come first and where to begin the construction activities. Most special provisions will require the contractor to submit a written traffic control plan and sequence of operations prior to commencing construction operations. This allows the field project manager the ability to schedule his crew's operations and to stay in front of the contractor's operations. A sample special provision for traffic control is shown in appendix B.

Specific traffic control devices are paid at varying unit rates. The contractor bids so much per traffic control device on a per unit basis. The units associated with the specific traffic control device are shown in the blue sheets of the special provisions. A sample of the rate schedule is shown in appendix B.

A. LANE CLOSURES

When the roadway is to be built under traffic, one lane must be open to the traveling public at all times. The contractor schedules his operations so

only one lane is closed and the other lane is used to move the traffic. Lane closures are common for cold milling, paving, guardrail, shoulder widening, and digout operations.

A typical lane closure is shown in appendix B and comes from standard drawing number 208. On two lane roadways the use of flaggers is required so traffic can alternate using the one traffic lane. If one way traffic exists, the proper devices will channel the traffic through the area.

In certain circumstances, such as bridge deck rehabilitation, the lanes are separated by concrete barrier rail and wide vehicles are restricted. If in doubt as to how to handle a situation, consult your design supervisor and/or the appropriate design section.

> ☞NOTE: The traffic control plan and special provision should be developed early in the design process. This special provision, in draft form, should be ready for the preliminary plan-in-hand and should be discussed and agreed upon at that time. Minor modifications can then be made as the design progresses.

VII CONTRACT DOCUMENTS

The contract documents - the plans, cross sections, special provisions, standard drawings, and specifications book need to guide the contractor through the construction phase of the project. If the design is going to reflect a unique situation the contract documents must be modified or a new special provision or detail drafted. As the designer, try to follow the "by-the-book approach" as the contractor and construction personnel have dealt with this situation before and are comfortable with these procedures.

If the design is going to be modified or radically changed, the designer now has to spell out in detail what is to be done, how it shall be accomplished, and how it is to be measured and paid. This will put the contractor and construction crew on good footing, but do not be surprised if the construction crew or even the contractor still questions the designer's intent.

(We are all a little afraid of change, or doing things differently, and the construction crew or contractor is trying to put these fears to rest by assuring themselves of the designer's intent.)

With the re-introduction of the road design checkers, the Contract Plans Section will see more consistent designs. This process is going to take several years to completely implement as many projects in the system have not been designed consistently.

The team design concept is also going to promote more uniformity in the contract documents being produced. This is going to put more responsibility on the construction and maintenance personnel to provide feedback to the design personnel. The design personnel are going to have to accept this constructive criticism and strive to develop better design techniques and methods to produce better contract documents.

VIII BID ITEMS

The designer has a host of bid items to understand and these bid items are the heart of the MDT design and construction process. The designer is going to have to learn these bid items from both the design and construction viewpoints. The construction viewpoint is going to be the toughest to learn as very little resource material is available. The designer is going to have to request that the construction personnel help "educate" the design personnel. We should be holding more joint construction and design seminars and the design personnel should be invited to the construction seminars and vice versa. This is the only true way we will be able to work as a design team.

We also need to encourage cross training - designers working on construction projects and construction personnel working on preconstruction projects. The Department is making strides in these directions, but each individual employee is going to have to put that extra effort into understanding other viewpoints.

The designer is encouraged to consult the specifications book and standard drawings to understand the construction viewpoint on a bid item. If the text is not clear or if questions still remain, consult another experienced designer or construction

personnel. Also, question the construction personnel before, during, and after the plan-in-hands. Ask the checkers and contract plans personnel how the bid items have been used before.

The road design manual needs to expand and include construction oriented data. For example, cold milling equipment is usually manufactured in 6.25 foot and 12.5 foot widths. In order to cold mill a 12 foot driving lane the designer must specify (and set up replacement quantities) for 12.5 feet of cold milling.

Many other similar situations exist and must be brought to the designer's attention by the construction personnel. Once this fact is presented to the design personnel it should be shared with other design personnel so the repetitious type mistakes can be eliminated.

It must also be understood by all parties that our current bidding system doesn't always show true average bid prices. Many contractors are stretching the bidding rules and are unbalancing their bids. Unbalancing of a bid is the contractor's way of becoming more competitive by taking into account the time value of money and/or anticipating bid quantity project overruns or underruns.

Unbalancing of bids causes some average bid item prices to be artificially lowered and other items to be artificially raised. For example, many contractors have been dramatically increasing their mobilization to 20% - 30% of the entire project bid. Since a good portion of the mobilization bid item is paid up front (early in the contract) the contractor takes this "windfall" and invests it, and at the end of the project has realized more profit than a contractor who didn't unbalance his bid. At first glance, this may seem trivial, but it can have far reaching results when the artificially lowered average bid prices are used in the project nomination or engineer's estimate. This also becomes very apparent when design options are compared based on average bid prices.

The designer is encouraged to seek help when putting together average bid costs for design options so accurate results are obtained and correct design decisions can be made. The use of the average of the 3 low bids information, now available in the bid tabulations, as well as construction personnel, is a

step in the right direction. It is also important to take into account the number of projects the bid item was used on and the relative quantity on each project, as this can also dramatically impact the average bid cost for any specific bid item.

As designers, we must be careful not to have bid items which dump too many things into a specific bid item. The same is true for lump sum bid items. At times, lump sum bid items are appropriate, but if too may items get "lump summed," the contractor tends to hedge his bet and increase his bid cost dramatically. The use of the term "included in the price bid for other items" or "is considered incidental" can cause some additional problems if the actual cost is not incidental or if the included work becomes large in scope.

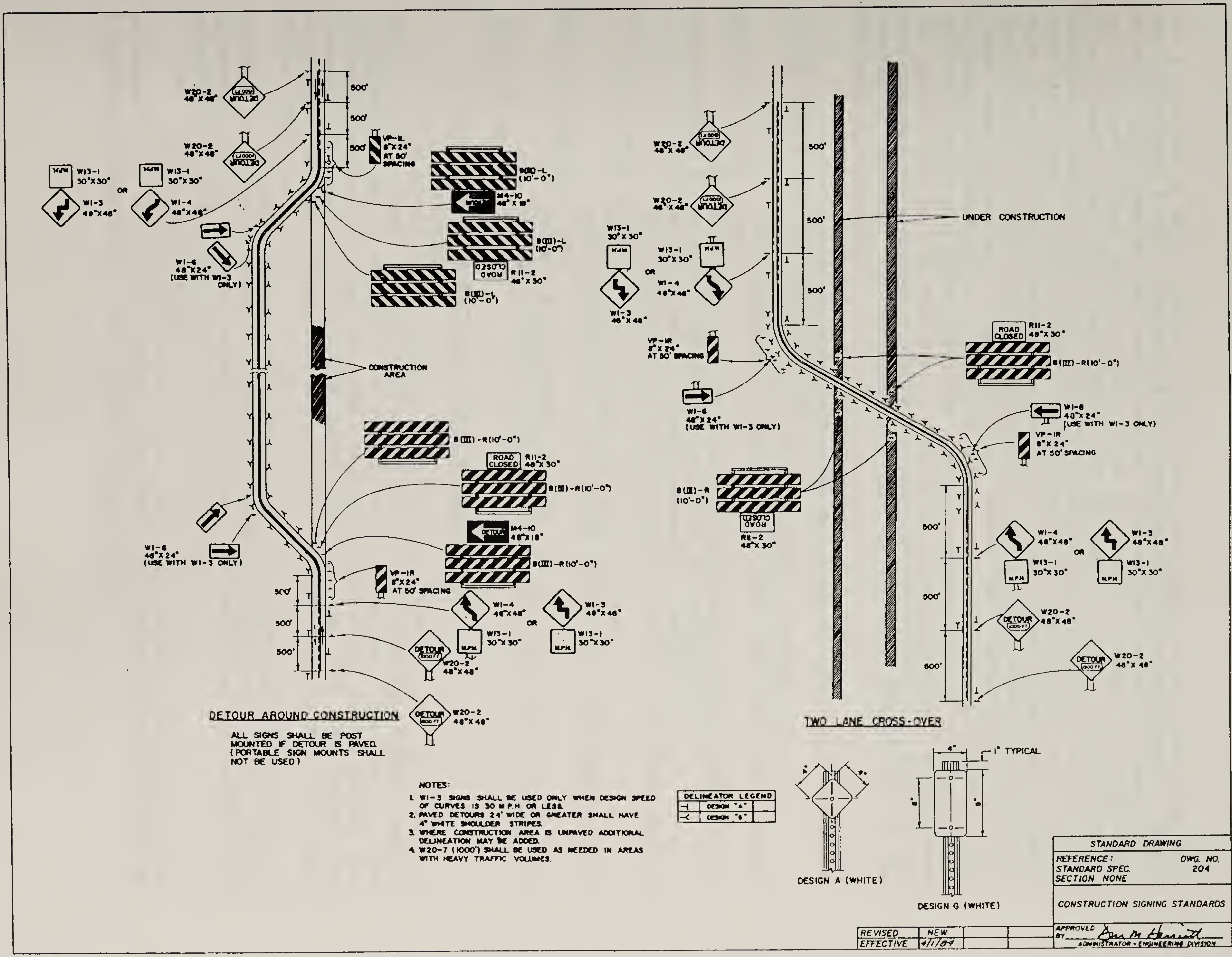
The contractor has learned that if a designer is unsure, these key phrases and "design tricks" can point to design problems, which most likely will lead to construction problems. Some contractors are licking their lips waiting for the "big one" - that change order or quantity overrun that is going to turn this "loosing hand" bid into a gold mine. It doesn't happen very often, but it does still need to be addressed as a potential problem.

IX SUMMARY

In summary, communications cannot be overemphasized. Communications between the MDT personnel is the key to reducing a lot of the design/construction problems we are facing today. The MDT is moving in a new direction and the design, construction, and maintenance personnel are being asked to join the same team. This team concept has many advantages, and most importantly, if good communications are used, the maintenance problem that can be traced to construction and ultimately to design can be eliminated. Then the MDT can start concentrating on other problems.

This is not going to happen overnight, but with help from all parties, it can happen in a smooth transition period. With new personnel and new procedures, some "easy" design and construction mistakes are going to be made. We must watch for these mistakes and, when we determine a mistake has been made, we must learn from that mistake and proceed to concentrate on other problems.

APPENDIX A:



DETOUR AROUND CONSTRUCTION

ALL SIGNS SHALL BE POST MOUNTED IF DETOUR IS PAVED. (PORTABLE SIGN MOUNTS SHALL NOT BE USED)

TWO LANE CROSS-OVER

NOTES:

1. W1-3 SIGNS SHALL BE USED ONLY WHEN DESIGN SPEED OF CURVES IS 30 M.P.H OR LESS.
2. PAVED DETOURS 24' WIDE OR GREATER SHALL HAVE 4" WHITE SHOULDER STRIPES.
3. WHERE CONSTRUCTION AREA IS UNPAVED ADDITIONAL DELINEATION MAY BE ADDED.
4. W20-7 (1000') SHALL BE USED AS NEEDED IN AREAS WITH HEAVY TRAFFIC VOLUMES.

DELINEATOR LEGEND		
⊣	DESIGN "A"	
≺	DESIGN "G"	

STANDARD DRAWING

REFERENCE:
STANDARD SPEC.
SECTION NONE

DWG. NO.
204

CONSTRUCTION SIGNING STANDARDS

APPROVED BY
ADMINISTRATOR - ENGINEERING DIVISION

REVISED	NEW		
EFFECTIVE	4/1/84		

on a 24-hour a day, 7 days a week basis, and shall make known the name of the person to the engineer at the preconstruction conference. While traffic is diverted for construction of a digout area all guardrail, milling and other work in the closed off section shall be completed. The digout area shall be backfilled as soon as it is excavated and completed through the first lift of paving before traffic is allowed to use the lanes. Each detour shall consist of two crossovers; one to move traffic across the median and into a two-lane two-way arrangement and another to get traffic back across the median into its normal 4-lane configuration. Each detour shall be constructed to the approximate dimensions as shown in the notes and to the satisfaction of the engineer and removed with the median restored to its original shape as determined by the engineer. The cost of construction, maintenance and removal of the detour shall be paid for at the unit price bid for median crossover. Listed below are the approximate locations for the detours by milepost.

(a) Detour 1 - EB digout 394+00 - 433+00
Two crossovers, EB - WB and back to EB. One crossover at MP 261.8 and the other at 265.1.

(b) Detour 2 WB two digouts 407+21 - 550+50
Two crossovers, one at MP 267.1 WB - EB and one at MP 261.8 back to WB.

(c) EB digout 592+50 - 614+50 use ramps at Milligan Canyon Interchange to detour traffic off and back on to mainline.

(d) Detour 3 WB 4 digouts 669+50 - 749+50
Two crossovers, one at MP 271.6 WB - EB and one at MP 268.4 back to WB.

(e) Detour 4 EB digout 703+50 - 710+00
Two crossovers, one at MP 269.4 EB - WB and one at MP 271.6 back to EB.

(f) Detour 5 EB digout 946+00 - 950+00
Two crossovers, one at 274.1 EB - WB and one at 274.4 back to EB.

CONCRETE MEDIAN RAIL AND IMPACT ATTENUATORS

A. Description

The contractor shall furnish 800 linear feet of concrete median rail (see standard drawing #84) and two portable impact attenuators which are to be positioned as noted elsewhere. The concrete median rail and portable impact attenuators shall become the property of the State at the conclusion of the job and, shall be delivered to the Transportation Department maintenance yard at Three Forks, Montana.

Portable impact attenuators shall be the six bay G.R.E.A.T. System as manufactured by Energy Absorption Systems, Inc., or an approved equal. Impact attenuators shall be installed and maintained according to the manufacturer's instructions.

B. Basis of Payment

All costs associated with the fabrication, transportation, placement and moving the above items shall be included in the cost of "Concrete Median Rail" and "Impact Attenuators."

APPENDIX A:

☞NOTE: Most detour special provisions are incorporated into the Traffic Control and Sequence of Operations special provisions as illustrated below:

TRAFFIC CONTROL PLAN AND SEQUENCE OF OPERATIONS

A. Traffic Control

Traffic control shall be accomplished and paid for in accordance with the "Traffic Control Provisions" (blue sheets) found elsewhere in this proposal, and the following plan.

(1) Digout Areas

There are a number of digout areas on this project. In these areas it will be necessary for the contractor to detour traffic to the other set of lanes and run traffic both directions on these lanes as discussed elsewhere in this special provision. Only one detour will be allowed at a time, and 4-lane traffic shall be back in operation prior to another detour being placed in operation.

(2) Guardrail and Milling Work

In the areas where there are no digouts, the contractor shall maintain one lane traffic through the work area at all times.

B. Sequence of Operations

(1) Detour Areas

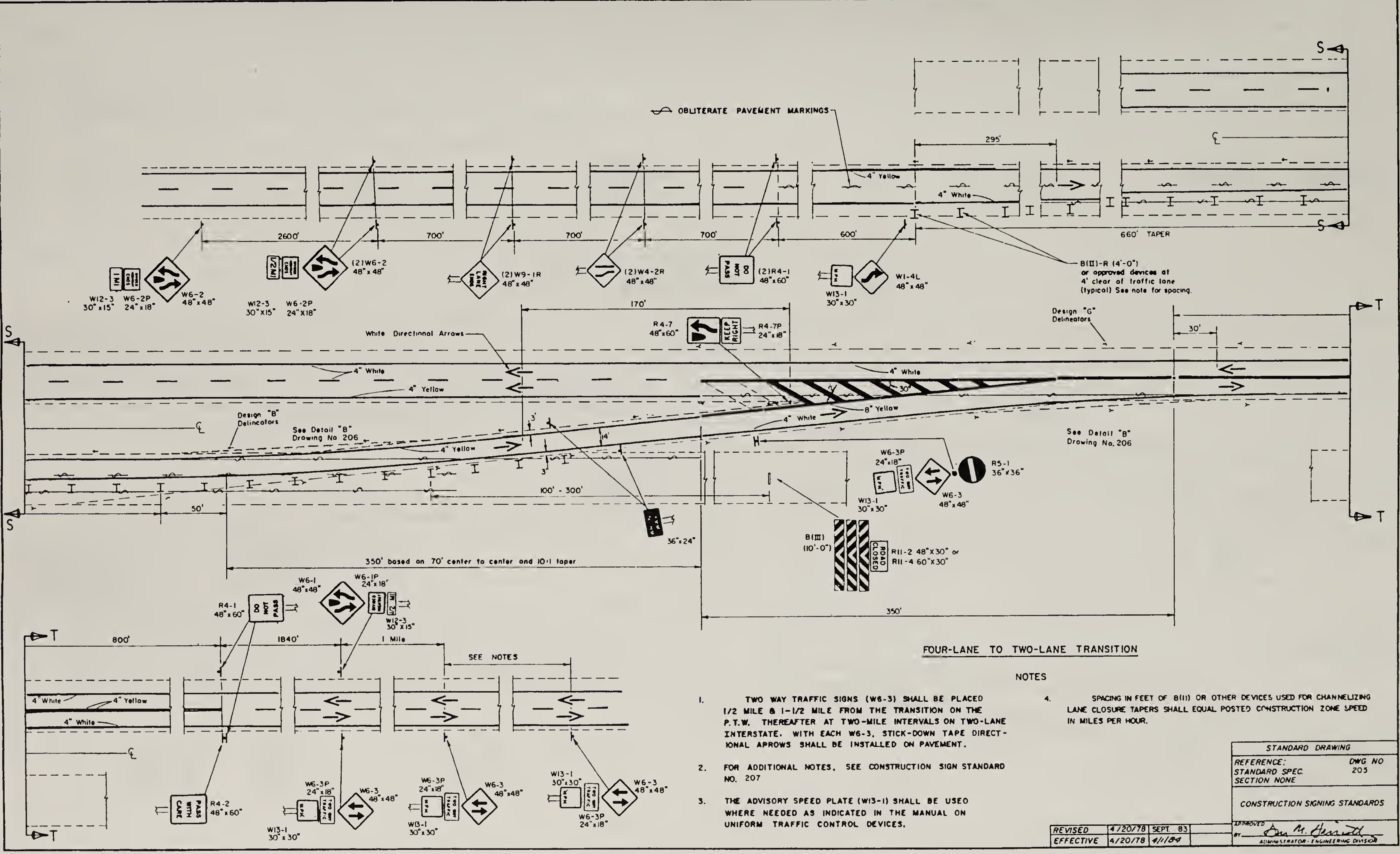
In the detour areas it will be necessary to run traffic two ways on one set of lanes. Traffic shall be detoured across the median using the signs, devices, and pavement markings as shown in "Standard Drawing" numbers 205, 206, and 207.

(a) Crossover Construction: The area of the median used as a crossover shall be surfaced as specified on the notes sheet in the plans.

(b) Median Barrier Rail: At the crossings themselves it will be necessary to use Median barrier Rail to separate the two directions of traffic, the contractor shall furnish and install the rail to the satisfaction of the engineer. Payment will be at the unit price bid per lineal foot of concrete median rail.

(c) Impact Attenuators: At all median barrier rail ends exposed to traffic an impact attenuator shall be used to protect the end. It shall be the responsibility of the contractor to install and maintain the attenuators according to the manufacturer's instructions.

(d) Median Traffic Separation: In addition to the traffic control items shown on the standard drawings it will be necessary to separate two-way traffic between the crossings with devices at 100' spacing on centerline. It shall be the responsibility of the contractor to select the type of device to be used and submit it to the Engineer for approval prior to use. Only an approved device shall be used. It will also be necessary to install post mounted (W6-3, 48"x48") two-way traffic signs and post mounted (R4-1), 30"X36") do not pass signs at 1/2 mile intervals through the length of the two-lane two-way traffic areas. All signs, devices, and pavement markings necessary to accomplish and maintain these areas will be included in the unit price bid for traffic control devices. The contractor shall have a person responsible for maintaining the traffic control devices



FOUR-LANE TO TWO-LANE TRANSITION

NOTES

1. TWO WAY TRAFFIC SIGNS (W6-3) SHALL BE PLACED 1/2 MILE & 1-1/2 MILE FROM THE TRANSITION ON THE P.T.W. THEREAFTER AT TWO-MILE INTERVALS ON TWO-LANE INTERSTATE. WITH EACH W6-3, STICK-DOWN TAPE DIRECTIONAL APROWS SHALL BE INSTALLED ON PAVEMENT.

2. FOR ADDITIONAL NOTES, SEE CONSTRUCTION SIGN STANDARD NO. 207

3. THE ADVISORY SPEED PLATE (W13-1) SHALL BE USEO WHERE NEEDED AS INDICATED IN THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES.

4. SPACING IN FEET OF B(II) OR OTHER DEVICES USED FOR CHANNELIZING LANE CLOSURE TAPERS SHALL EQUAL POSTED CONSTRUCTION ZONE SPEED IN MILES PER HOUR.

REVISED	4/20/78	SEPT. 83
EFFECTIVE	4/20/78	4/1/84

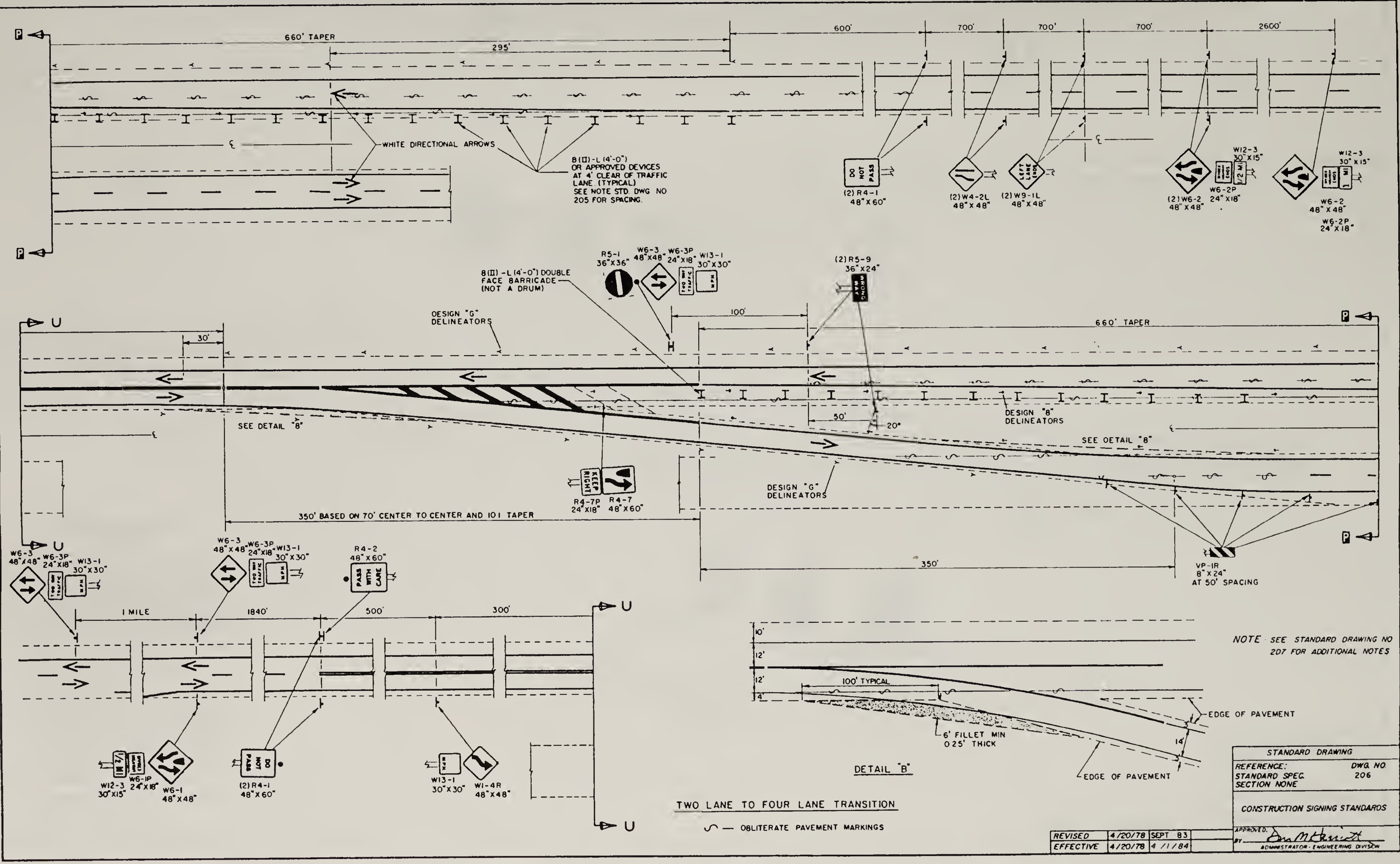
STANDARD DRAWING

REFERENCE:
STANDARD SPEC
SECTION NONE

DWG NO
205

CONSTRUCTION SIGNING STANDARDS

APPROVED BY
ADMINISTRATOR - ENGINEERING DIVISION



DETAIL "B"

NOTE: SEE STANDARD DRAWING NO 207 FOR ADDITIONAL NOTES

TWO LANE TO FOUR LANE TRANSITION

∽ — OBLITERATE PAVEMENT MARKINGS

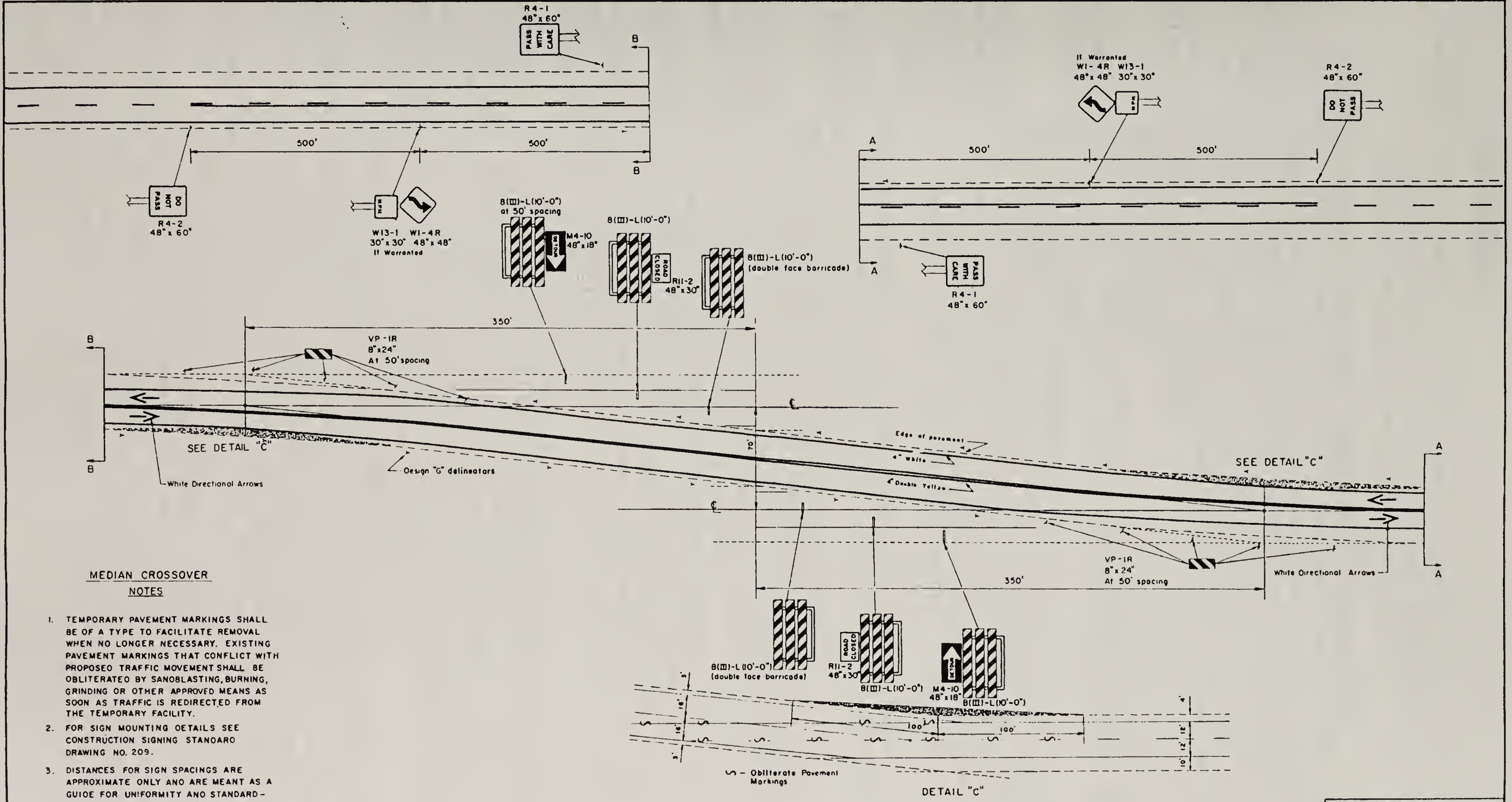
REVISED	4/20/78	SEPT 83
EFFECTIVE	4/20/78	4/1/84

STANDARD DRAWING

REFERENCE: DWG. NO.
STANDARD SPEC. 206
SECTION NONE

CONSTRUCTION SIGNING STANDARDS

APPROVED BY Don M Barnett
ADMINISTRATOR - ENGINEERING DIVISION



MEDIAN CROSSOVER NOTES

1. TEMPORARY PAVEMENT MARKINGS SHALL BE OF A TYPE TO FACILITATE REMOVAL WHEN NO LONGER NECESSARY. EXISTING PAVEMENT MARKINGS THAT CONFLICT WITH PROPOSED TRAFFIC MOVEMENT SHALL BE OBLITERATED BY SANDBLASTING, BURNING, GRINDING OR OTHER APPROVED MEANS AS SOON AS TRAFFIC IS REDIRECTED FROM THE TEMPORARY FACILITY.
2. FOR SIGN MOUNTING DETAILS SEE CONSTRUCTION SIGNING STANDARD DRAWING NO. 209.
3. DISTANCES FOR SIGN SPACINGS ARE APPROXIMATE ONLY AND ARE MEANT AS A GUIDE FOR UNIFORMITY AND STANDARDIZATION. USE JUDGEMENT AND REASONABLE TOLERANCE FOR SIGN INSTALLATION.
4. CROSSOVER TAPER SHALL BE: 1 TO 10 DESIRABLE, 1 TO 8 MINIMUM
5. SUGGESTED SUPER OF CURVE TO BE 0.02 FT/FT MINIMUM.

REVISED	4/20/78	MAY 1983	
EFFECTIVE	4/20/78	4/1/84	

STANDARD DRAWING

REFERENCE: DWG NO
STANDARD SPEC. 207
SECTION NONE

CONSTRUCTION SIGNING STANDARDS

APPROVED
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ADMINISTRATOR - ENGINEERING DIVISION

APPENDIX B:

☞NOTE: Most Traffic Control special provisions are incorporated into the Traffic Control and Sequence of Operations special provision as illustrated below:

TRAFFIC CONTROL PLAN AND SEQUENCE OF OPERATIONS

No work shall begin on this contact until the engineer has approved a sequence of operations submitted by the contractor. The contractor shall submit the written sequence of operations a minimum of two weeks prior to any anticipated work on this contract.

The proposed sequence of operations will, in the opinion of the engineer, assure that the Standard Specifications, as well as the following requirements, are met:

A. Traffic Control

Traffic control shall be accomplished and paid for in accordance with the "Traffic Control Provision" (blue sheets) found elsewhere in this proposal.

B. Coordination of Operations

In addition to the requirements of Section 104.04, Maintenance of Work, and Section 108.04, Limitation of Operations, the contractor and/or subcontractors shall schedule and coordinate their operations. Proper signing, delineation and barricades shall be utilized to protect the traveling public and the contractor's personnel.

The contractor and/or subcontractors shall schedule and coordinate their operations so that they are conducted in a well-organized and efficient manner.

C. Roadway Closure and Public Advisory

The roadway adjacent to the Sweet Grass bridge will be closed to through traffic during construction. A detour shall be developed utilizing FAS 478 beginning approximately 3 miles N.E. of Big Timber to approximately 13 miles N.E. of Big Timber.

The detour of traffic for this project will only take place between May 15th and August 15th. This is in agreement with the Sweet Grass County Commissioners in order to accommodate calving and crop harvesting seasons. However, other such work by the contractor that doesn't require traffic to detour around the project may be completed outside of this time block.

The contractor shall develop and distribute to all adjacent residents and businesses a written summary of the intended operations. the summary shall include a brief description of work, the intended time period of various parts of the work, and possible effects on residents such as alternate access routes and construction traffic. It should also include the contractor's name and telephone number that can be contacted in case of problems or complaints.

D. Sequence of Operations (Bridge)

1) The contractor shall construct the roadway embankment to the berm elevation prior to beginning construction of the end bents.

2) Riprap located within the limits of the superstructure shall be placed prior to constructing the superstructure.

3) The new structure and approaches will be inspected and approved before traffic is allowed on the new construction.

E. Basis of Payment

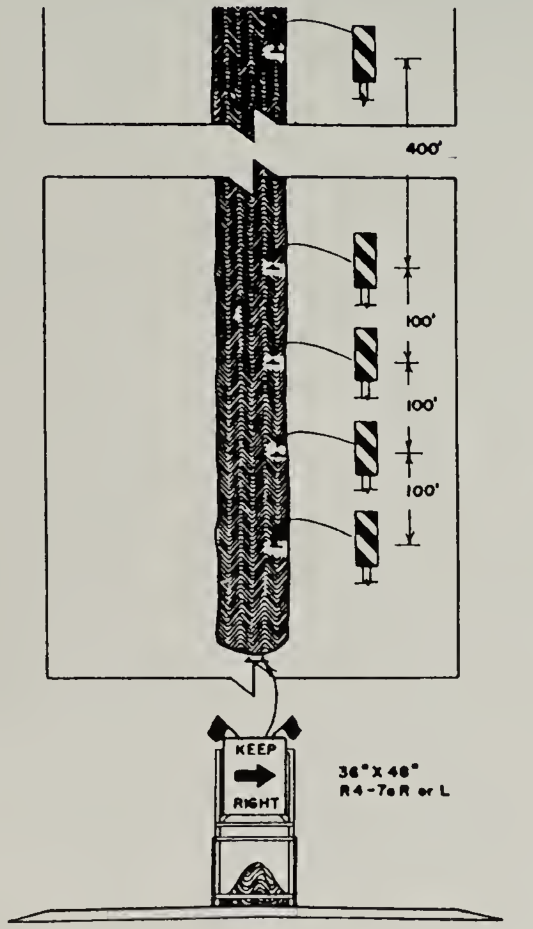
1) Sequence of Operations: No extra compensation will be considered or allowed by reason of the conditions of this provision as it shall be considered necessary and incidental to the completion of the work. Failure to complete the necessary work within the allowed road closure dates shall be grounds for the state to withhold payments to the contractor as specified in Section 108.08 of the Standard Specification.

Rev. 8-1-92

TRAFFIC CONTROL RATE SCHEDULE

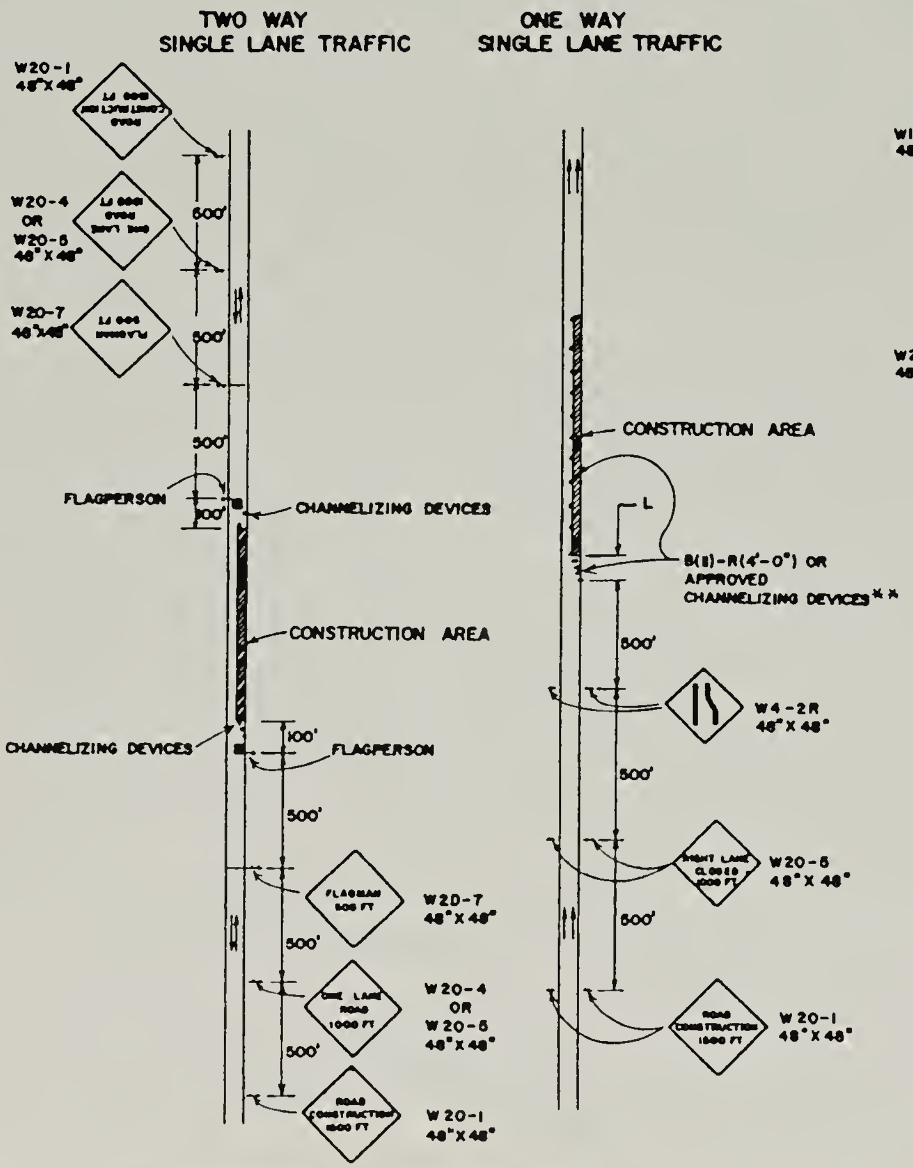
*(See Sections 618.04 & 618.05 of the Standard Specifications)

GROUP NO.		TRAFFIC CONTROL DEVICE DESCRIPTION	VALUE IN UNITS OF EACH TRAFFIC CONTROL DEVICE
1.	Any Size Sign	Signs on Portable Mounts	12/each
2.	Sign Faces up to 15.9 square feet	Signs Mounted on Single Post	90/each
3.	16.0 up to 19.9 square feet	Signs Mounted on Single Post	120/each
4.	20.0 up to 29.9 square feet	Signs Mounted on Single Post	140/each
5.	30.0 up to 40.0 square feet	Signs Mounted on Single Post	170/each
6.	10.0 up to 18.1 square feet	Signs Mounted on Two Posts	150/each
7.	50.0 up to 59.9 square feet	Signs Mounted on Two Posts	400/each
8.	Sign Faces up to 20.0 square feet	Signs Mounted on Barricade Signs Mounted on Pilot Car	45/each
9.	8"x24" 12"x36"	Vertical Panel " "	15/each
10.	8"x24" Portable	Vertical Panel (reflectorized both sides)	4/each
11.	4′-0" to 10′-0"B (III)	Barricade (reflectorized on one side)	150/each
12.	4′-0" to 10′-0"B (III)	Barricade (reflectorized both sides)	200/each
13.	4′-0" to 10′-0" B(I)&B(II)	Barricade (Std. Dwg. No. 210)	75/each
14.	B(I) & B(II)	Commercial Barricade (2′ min length)	4/each/day
15.	Barricade Warning Lights (1) Type A - Low Intensity (2) Type B - High Intensity (3) Type C - Steady Burn		 3/each/day 4/each/day 3/each/day
16.	Drums Plastic		5/each
17.	Move and reset vertical panels, delineators		3/each
18.	Delineators (Design A,B,&G)		10/each
19.	Remove 4" paint stripe		1.0/LF
20.	Water for dust control		20.0/M Gal.
21.	Flexible guide posts		2/each
22.	Flasher boards mounted on truck or trailer (Flashing Arrow or Sequential Arrow)		5/each/hr.
23.	W20-7 sign w/two 12" flashers includes sign		4/each/hr.
24.	Raised rigid pavement markers Type I or II (install/remove)		2/each

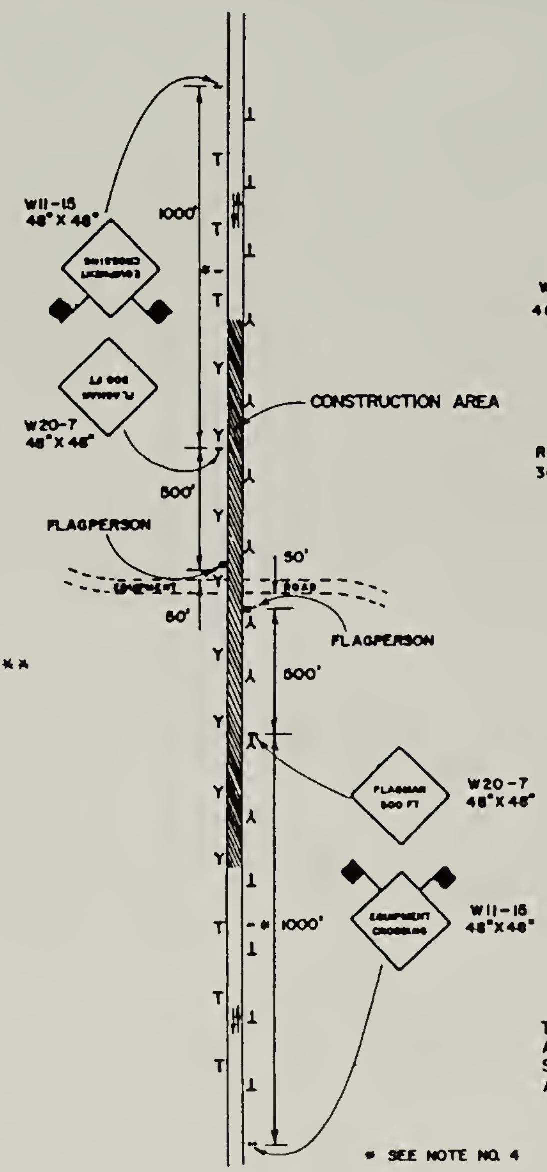


1. WINDROWS SHALL BE MARKED WITH VERTICAL PANELS, VP-1 RIGHT OR LEFT, AS REQUIRED. FOLLOWING THE APPROACH TREATMENT, VERTICAL PANELS SHALL BE SPACED AT 400' THROUGHOUT THE ENTIRE LENGTH OF THE WINDROW.
2. TWO 12" X 12" ORANGE FLAGS SHALL BE MOUNTED ON ALL "KEEP RIGHT(LEFT)" SIGNS USED AT WINDROWS. FLAGS SHALL BE MOUNTED SO THEY WILL BE HIGHER THAN THE SIGN FACE.
3. IF A WINDROW IS NOT BEING WORKED, VERTICAL PANELS MUST BE IN PLACE.
4. SEE STANDARD DRAWING NO. 209 FOR TYPICAL PORTABLE SIGN MOUNTING.

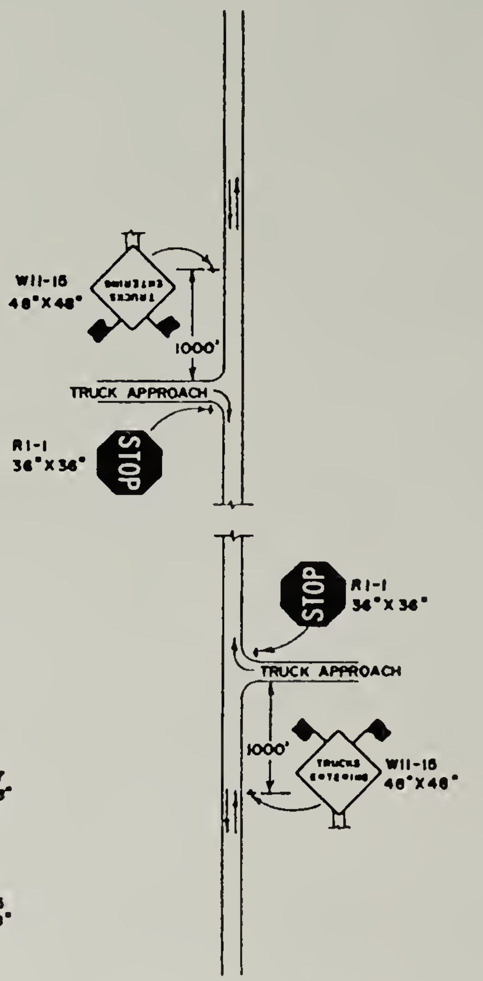
TYPICAL WINDROW SIGNING



SIGNING FOR LANE CLOSURE



EQUIPMENT CROSSING
IN CONSTRUCTION AREA



TWO ORANGE FLAGS SHALL BE MOUNTED ON ALL W11-15 SIGNS. FLAGS SHALL BE MOUNTED SO THEY WILL BE HIGHER THAN SIGN FACE AS SHOWN. FLAGS SHALL BE 12" X 12" MINIMUM.

SIDE ROAD APPROACH SIGNING

45 M.P.H. SPEEDS & GREATER L = WS
40 M.P.H. SPEEDS & LESS L = $WS^2/60$

L = MINIMUM LENGTH OF TAPER
S = NUMERICAL VALUE OF POSTED SPEED LIMIT PRIOR TO WORK OR PERCENTILE SPEED
W = WIDTH OF OFFSET

* * SPACING OF CHANNELIZING DEVICES IN FEET IS EQUAL TO POSTED CONSTRUCTION ZONE SPEED IN MILES PER HOUR.

REVISED	NEW		
EFFECTIVE	4/1/84		

STANDARD DRAWING
REFERENCE: DWG. NO.
STANDARD SPEC. 208
SECTION NONE

CONSTRUCTION SIGNING STANDARDS

APPROVED
BY Don M. Harriott
ADMINISTRATOR - ENGINEERING DIVISION

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